

## **Image re-building. Anastylosis of Ancient Buildings Towards a Methodological Process innovation**

**Valentina Santoro**  
Polytechnic of Bari/ DICAR  
Via Valente, 24, Fasano Bari, Italy  
valentinasantoro@yahoo.it

### **ABSTRACT**

This paper proposes a theoretical-experimental study on “image re-building” of ancient buildings, focusing on the anastylosis and the restoration of stone monuments. As a part of a much broader studies based on the anastylosis of Greek and Roman monuments conducted by Giorgio Rocco and Monica Livadiotti, professors at Polytechnic University of Bari, this research moves from the most recent guidelines about archaeological restoration arising from the multi-year experiences in Greece.

As we know, the theories of restoration need for ongoing control about their applications and this is an essential support to technological innovation. The restoration work of the Acropolis in Athens plays a key role in the Mediterranean area and a resource for the "science" of restoration because, in this case, researchers and experts have conducted an important technical and methodological experiment of restoration for about 40 years. In fact, this experience has introduced the criterion of reversibility and a particular attention to the preservation of original structural system of ancient monuments, updating the principles established in the Charts of Restoration.

According to the recent guidelines on preservation, we choose now to use compatible materials, in continuity with the ancient technique of stone buildings. Furthermore, as regards the anchoring systems, that are sometimes indispensable in static reinforcement of stone architectural blocks, the researchers are studying new reversible systems (like titanium used in restorations of the Acropolis in Athens), to insert in existing sockets, if possible. During the restoration, use of special resin materials with high irreversibility, still used in Italy, and cutting of antique material are banned.

While in Greece important results have been obtained through the cooperation with qualified institutions like the YSMA (The Acropolis Restoration Service), in Italy we can notice a methodological and procedural delay. The stone deterioration in the monuments of Archaic, Classical and Hellenistic period in Magna Graecia and Sicily makes the situation worse.

Through some direct and indirect experiences, this paper describes a methodology of image re-building and anastylosis of ancient buildings and analyzes the limits and opportunities of using advanced technologies in restoration projects.

**KEYWORDS:** anastylosis, integration, restoration, re-building, reversibility

The will to rebuild the image of the ruins of antiquity, already present in Italy in the early integrations of the late 18th century, is made official on the occasion of Athens' Conference in 1931, in a time when it was needed to agree with a unified methodology of intervention.

In particular, a careful consideration to each fragment found during the archaeological excavation was imposed, and it was expressly recommended, when possible, to put back the original elements found

(anastylosis) and to make recognizable the new materials that had been introduced into the text because of the purpose.

This practice, already pointed out, in the first decade of the last century, by Giovannoni (Giovannoni 1931, p. 18), is made official also during the Athens Conference in 1931 (Infranca, 1999; Icomos 2004), which recognized a leading role to the archeological site of Acropolis of Athens.

Because of the political instability and the important financial difficulties of that period, all national restorations were stopped, except for those of the Acropolis of Athens (Figure.1), supervised by Nikolaos Balanos. From now on, the term 'anastylosis' come into the common lexicon of archaeological restoration, such as contextual intervention to excavation operations, aimed to preserve the architectural fragments found in situ.



Figure 1: The Parthenon after the early twentieth-century's restorations of Balanos.  
(Photo from E. Kolyvaki, 2000, YSMA Archive in Lambrinou L. 2010, p. 65).

The Athenian experience had a crucial role in the education of the young Italian architects and archeologists who, in addition to their suitable technical knowledge, seem to be supported by humanities in the supervision of important restoration works, today very remarkable (Livadiotti, Rocco 1996, Livadiotti, Rocco 2012, Livadiotti, forthcoming).

However, in Italy, the conservation has been rather translated into a practice of consolidation (D'Agostino, Stendardo 2008; Tocco Sciarelli 2007), at the beginning conditioned by the will to re-employ the greater number possible of architectural fragments found during the excavations, then supported by instructive and educational aims.

The state of preservation is critical, in fact, especially in the archaeological sites of South Italy and Sicily, already compromised by invasive restorations with reinforced concrete and by the most recent employment of epoxy.

There is a methodological and procedural delay in our country, compared to the results obtained by the studies of highly qualified institutions like, in Greece, YSMA (The Acropolis Restoration Service) (Ysma 2010), which supported the thirty-year experience of the restoration of the Acropolis of Athens (Rocco, forthcoming). According to the recent requirements of YSMA, therefore, the materials used in the restoration of the Greek monuments must be non-invasive and compatible with the authentic materials so as not to cause damage in the future (Ioannidou, 2007).

Compliance with the criterion of reversibility, suggested by the Greek experience, becomes necessary at all stages of the restoration project, which certainly aims to the conservation of the work, beyond any educational and informative instance.

In addition, special attention was paid to preserve the original static system, that is to comply with the authentic material, the only one which guarantees the conservation of the structural autonomy of architectural elements, in order to ensure that the original parts and the restored ones act equally, also in case of seismic event (Mallouchou-Tufano, Alexopoulos, 2003). The reconstruction of the image has the only purpose of recovering the formal and structural integrity (Eleutheriou, forthcoming, Karanassos, forthcoming, Vrouva, forthcoming).

Despite the clarifications in the art. 9 of the Restoration Italian Chart and the evolution of methodology, it has been observed an almost total absence of structural project, sometimes supported by the experience of the same workers in the construction site.

It is well-known, in fact, that majestic archaeological evidences of our South of Italy appear deteriorated. From the second half of the twentieth century until the recent interventions, in fact, the method of insertion of the metal bars and glass fibers in the stone material is substantially the same as that used for the concrete, with a consequent alteration of the original static system.

For nearly a century, the lack of a calculation methodology valid for the static consolidation of the stone, made the condition of ancient monuments in Sicily and Magna Grecia even more precarious (D'Agostino, 1997; Cipriani, Avagliano 1993; D'Agostino, 2007).

In the early years of the twentieth century it was considered methodologically valid to improve the mechanical strength of a capital incorporating in the abacus the iron scaffold embedded in mortar, just as happened for the capitals of the temple of Heracles in Agrigento (Figures. 2, 3) and temple C of Selinunte (Figures. 4, 5).



Figures 2, 3: The Heracles temple in Akragas after the eng. F. Valenti restorations (1922-1924);  
The capital with iron and mortar cement (in Ferrara 2010, p. 185).

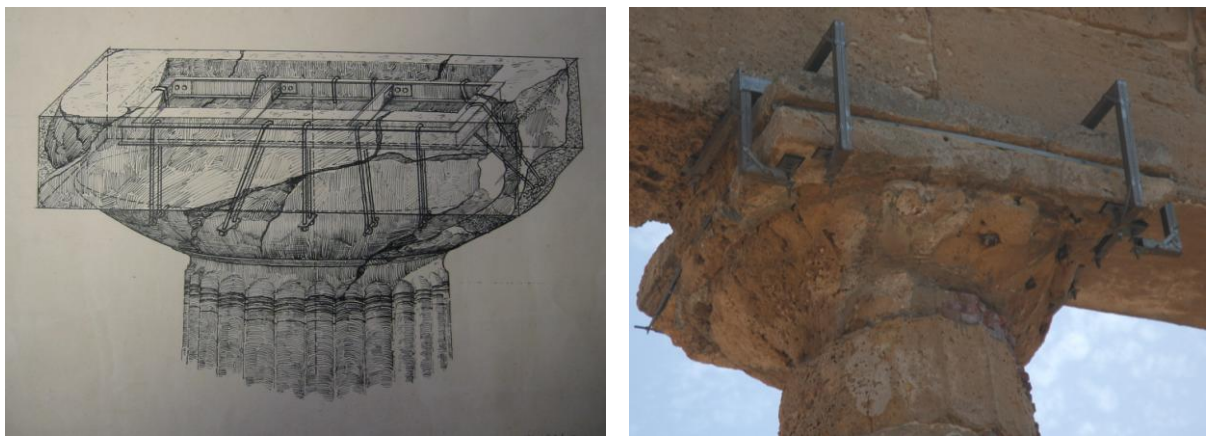
In order to reassemble the sixteen columns in the northern front of the C temple, eng. Valenti used a mixture of brick and mortar for the structural part (AMAR, CM), while the grooves were modeled with a mortar dough that simulated the original stone; the conserved fragments, however, were connected with drawn copper pivots incorporated in the same cement mortar, according to a practice quite common at that time.

The intervention in Poseidonia, dating thirty-six years after those of Selinous and Agrigento, is an expression of how the technique of reinforced concrete, borrowed from the civil field, has continued to affect the archaeological structures in the South of Italy. In this particular case, the damage caused to the original static system are so important that the whole entablature of the eastern front can be equate to the layout of a modern continuous beam made of reinforced concrete (Cipriani, 2007).

In addition, the consequence of an excessive introduction of iron in the lytic system is the increased vulnerability to lightning, as was the case in the elymian temple of Segesta with significant damage on the front.

The irreversibility of these transactions, together with technical and technological lack of competence in proposing decisive hypothesis for the de-restoration of ancient monuments, that is the impossibility to provide for a controlled removal of previous interventions without damage to the original fabric, had been compensated in some cases by artificial and temporary interventions, such as protective covers or tubular bracing scaffolding that, persisting longer than necessary, have worsened the conservative status, like in the recent case of the fountain of Akagras (Fino, forthcoming, Santoro, forthcoming), already compromised by invasive and ineffective interventions.

The original static system, in fact, showed significant structural tampering, accentuated by the detrital and clayish nature of the soil and exacerbated in recent times by the presence of a large number of metal pivoting.



Figures 4, 5: Temple C, *Selinous*. Drawing for the capital restorations project (1926-1929) (In Ferrara 2010, p. 200); Temple C Selinous, the capital (2012, photo from A.).

The structural balance appeared further threatened by the presence on the forecourt of an entirely inappropriate system of shoring up the facade that, apart from hiding it, led to an enduring and steady worsening of the state of conservation of the monument, due to the excessive weight determined on the structure itself.

Although in this case the intervention is configured as an opportunity in extremis or a conservative need, the structural de-restoration remains in general a further action on architecture, a priori uncontrollable and, for this, it would be possible to evaluate the limits and scenarios only in a marginal way and case by case; however, when you choose to take such a way, you have to consider the replacement of an a priori unpredictable number of blocks that may get lost during disassembly (Santoro, forthcoming).

The results achieved have certainly been affected by the nature and the state of preservation of the material, by the de-restoration techniques used, and by the presence of a group with specific competence (archaeologists, architects, engineers, geologists, physicists, chemists, etc.) in charge of monitoring the various stages of the archeological site, according to the logic of decisions in itinere of the government.

In addition, as recommended by the Chart of Venice (Bouras 1994, pp.88-91), the systematic documentation (Alexopoulos, 2010) during the work, is directly linked to the principle of reversibility and of the minimum intervention on the each architectural element (Mallouchou-Tufano, Alexopoulos, 2003).

In several ancient monuments in Rhodes we could find a comparison similar to the peculiarities of the Sicilian monuments, regarding to materials and environmental exposure (Papachristodoulou 1988).



The Acropolis of Lindos was restored by Italians (Laurenzi , 1938) in 1995. The de-restoration interventions of the structures in poros of the Athena temple and of the Hellenistic Stoa, oriented to remove metal armor introduced by the Italian intervention in 30s, was carried out in the attempt to retrieve its consolidated role, on the base of the recent trends introduced by Athenian experiences (Eleftheriou, Markou 2012). However, the case of Lindos is now known for the large number of new integrations included in the original structures and for the losses of ancient materials determined by the de-restoration.

Similarly to what happened in Greece, we have a philological and theoretical problem about the conservation of Greek and Roman monuments of South Italy and Sicily, in part irreversibly compromised, which can't stand other intervention without further damage to the ancient material (Mertens 2007; Rocco, forthcoming).

The current issue does not accept ideological aims of a return to the neo-classical purism as is often happened in Greece (Gizzi, 2003), but emphasizes the Italian lack of a national methodology.



Figures 6, 7: The restoration of the Acropolis of Athens. The materials integration by the use of a stereo pantograph (Photos by A. from EfA, Seminaire doctorale 2013).

Italy seems to be now incompetent in providing theoretical and practical information about possible restoration projects aimed to protect important archaeological sites and to preserve the identity of the place, linked to its multiple historical, landscape and architectural characteristics (Dalla Costa, Carbonara 2005).

In the actual researches, together with the already known ability to replicate complex architectural elements, (D'Amato, 2002), special interest is directed to the development of a methodological procedure for the integration of elements in stone, using material conforms to the original one and in continuity with the processing techniques used in ancient times.

The aim is to verify the real support that advanced technologies, like 3D laser scanner and CNC CAD / CAM, can give to the traditional systems of planning and prototyping the element.

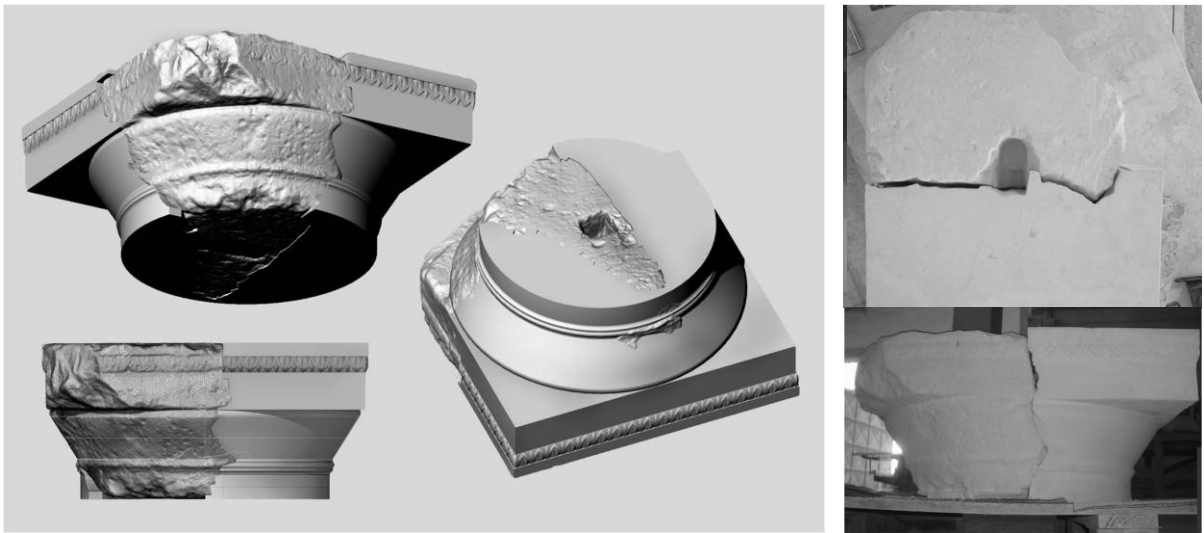
Traditional methods for a 1:1 scale (and not only), used in the restoration of the Acropolis of Athens, provide for a stereo pantograph (Figure.6, 7), created for the occasion by the supervisor M. Korres, (Mallouchou-Tufano, pp. 31-40).

The test launched in 2010 is still ongoing between the Polytechnic of Bari and the Pi.Mar, a leader in the field of stone and technological innovation, recently operating in testing methodological procedures sustainable for archaeological restoration.

The inter-disciplinary studies made possible in this case to combine the archaeological needs with the specialized, technical, engineering and technological ones, in line with the results of the recent experiences in Greece (Egglezos 2010; Eleftheriou, Netti 2011).

Furthermore, in agreement with the Science of Construction Department of the Polytechnic University of Bari, we are testing the use of innovative materials such as nickel-titanium shape memory alloys for the housing of new clamps and dowels, able to assure the material compatibility with stone, without chemical and static alterations, reducing the flush holes to few millimeters in diameter in a not invasive way.

In this regard, the first methodological tests had been applied on a sample fragment. It is a Doric capital in white limestone, attributable to the so-called Forum of *Egnatia*, dated between the end of the 1<sup>st</sup> century B.C. and the beginning of the 1<sup>st</sup> century A.D. The capital, a rare example preserved even not intact, was part of the internal order of the porch that bordered the square (Figures 8,9).



Figures 8, 9: A Doric capital from the porch of Egnatia's Forum. Project design and prototypes (Laser scanner and Cad Cam) (Pictures from A.).

The purpose of the operation was not the production of the physical model of the fragment, which has been anyway, duplicated scanning the original by a 3D laser because of the impossibility to operate on the ancient element, but rather an opportunity to test, integrate and optimize the traditional semantic algorithms for the anastylosis.

Without enter into the merits of the procedure followed, already described elsewhere (Santoro 2013), it is important to have verified that the standardization process of production by mechanical means can't exclude the presence of workers specialized in stone processing, especially in the moment of surface finishing, even if it lightened greatly the workload.

It is for that reason that we have to organize teams composed by peoples specialized in the ancient techniques and in the specific needs of archaeological monuments.

In line with the international results achieved by the archeological site of the Acropolis of Athens, the open question in Italy regard the necessity to invest in technical training of people specialized in the field of archaeological restoration for the conservation of our national cultural heritage.

## REFERENCES

- Alexopoulos, Y. 2010. Improvements and additions to the database of the documentation for the Acropolis works, in The Acropolis restoration News, proceedings of a one-day Conference. Modern technologies in the restoration of the Acropolis. M. Ioannidou, E. Petropoulou (Eds.). Athens, pp. 33-34.
- Amar, Rialzamento dei tamburi delle colonne, in Computo metrico, Cap III.
- Bartolini, M.I. 2012. La figura scientifica e l'attività archeologica a Cirene di Luigi Pernier tramite i contributi d'archivio, Tesi di Dottorato XXV ciclo, Macerata.
- Bouras, C. 1994. The international Chart of Venice and the Restoration of Classical Buidings, in Economakis, R. (Ed.), in "Acropolis Restoration", Academy Editions, London, pp.88-89.
- Cipriani, M., Avagliano, G. 1993. (Eds.). L'Athenaion di Paestum tra studio e restauro, Salerno.
- Cipriani, M. 2007. Dalle integrazioni lapidee del Bonucci alle impernature metalliche della Fondedile. Gli interventi di restauro dei templi di Pestum tra il 1805 e il 1962, in Cipriani M., Avagliano G. (Eds.). Il restauro dei templi di Poseidonia, Atti del Convegno Internazionale Paestum, giugno 2004, Ravenna, pp. 13-34.
- D'Agostino, S. 2007. La conservazione costruttiva dei templi di Paestum, in Cipriani M., Avagliano G. (Eds.). Il restauro dei templi di Poseidonia, Atti del Convegno Internazionale Paestum giugno 2004, Ravenna, pp. 49-70.
- D'Agostino, S. and Stendardo, L. 2008. Il restauro strutturale dei templi di Paestum dall'Ottocento all'attualità, in XXIV Conv. int. Scienza e Beni Culturali, Bressanone, pp. 1065-1074.
- Dalla Costa, M. and Carbonara, G. 2005. Memoria e restauro dell'architettura. Saggi in onore di Salvatore Boscarino, Milano 2005.
- D'Agostino, S. 1997. La reintegrazione nel restauro dell'antico: conservazione strutturale tra tradizione costruttiva e innovazione tecnologica, Billeci B., Gizzi S., Scudino D. (Eds.). La reintegrazione nel Restauri dell'Antico. La protezione del Patrimonio dal Rischio Sismico, Quaderni ARCO, Paestum, pp. 23-32.
- D'Amato, C. 2002. La replica del capitello 9A del tempio di Apollo Epicurio a Bassai, in Area, n. 62, pp. 134-143.
- Egglezos, D. 2010. The use of modern technological applications for restoring the circuit Walls of the Acropolis, M. Ioannidou, E. Petropoulou (Eds.) in The Acropolis restoration News, proceedings of a one-day Conference. Modern technologies in the restoration of the Acropolis., Athens.
- Eleutheriou, B. and Netti, R. 2011. Η Αγορά της Κω. Το έργο της απο-κατάστασης του Νότιου Τμήματος, in Giannikouri A. (Eds.), Ηαγορά στη Μεσόγειο. Από τους ομερικούς έως τους ρωμαϊκούς χρόνους, Διεθνές Επιστημονικό Συνεδρίο, Κως 14/17-04-2011, Athens, pp. 425-438.

- Eleftheriou, V. and A. Markou, A., 2012. The Acropolis of Lindos: the work of redesigning and enhancing the archaeological site, Thiasos, 1, pp. 29-34.
- Eleftheriou, V., The recent intervention programs on the monuments of the Athenian Acropolis, in *Il restauro dei monumenti antichi. Problemi strutturali: esperienze e prospettive*, Atti delle Giornate di Studio, Agrigento, 23-24 novembre 2012, Thiasos, 3, 2014, forthcoming.
- Fino, A., La Fontana Arcaica di S. Biagio, in *Il restauro dei monumenti antichi. Problemi strutturali: esperienze e prospettive. Convegno organizzato dall'Ente Parco Archeologico e Paesaggistico Valle dei Templi di Agrigento*, Agrigento 23-24 novembre 2012, in Thiasos, forthcoming.
- Ferrara, M.L. 2005. Anastilosi e reintegrazioni nei monumenti archeologici della Sicilia (secoli XVIII-XX), Tesi di Dottorato, Università degli Studi Napoli Federico II, Napoli.
- Giovannoni, G. 1931. La Conferenza Internazionale di Atene per il Restauro dei Monumenti, in *BdA*, p. 31-35.
- Gizzi, S. 2003. Il restauro dell'Acropoli a confronto con altre esperienze greche, Filetici M.G., Giovanetti F., Mallouchou- Tufano E., Pallottino E. (Eds.) *I Restauri dell'acropoli di Atene (1975-2003)*, Quaderni ARCO, Roma.
- Icomos, 2004. *International Charters for Restoration and Conservation*, Monaco.
- Ioannidou, M. 2007. The restoration project of the Acropolis Restoration Service, in Cipriani M., Avagliano G. (Eds.), in *Il restauro dei templi di Poseidonia*, Atti del Convegno Internazionale, Paestum giugno 2004, Ravenna, pp. 103-118.
- Infranca, G.C. 1999. *Manuale di restauro archeologico*, Roma.
- Karanassos, C. 2007. Modi di integrare le lacune nelle anastylosis attuali dei monumenti dell'Acropoli di Atene, in Cipriani M., Avagliano G. (Eds.), in *Il restauro dei templi di Poseidonia*, Atti del Convegno Internazionale, Paestum, giugno 2004, Ravenna, pp. 143-160.
- Korres, M. 1994. The Restoration of the Parthenon, Economakis, R. (Ed.), in "Acropolis Restoration", Academy Editions, London, pp.110-136.
- Lambrinou L. 2010. Preserving a Monument: the example of the Parthenon, (Acropolis Restoration Service, Athens, Greece) in *Conservation and management of arch. sites*, Vol. 12 No. 1, pp. 60-74
- Laurenzi, L. 1938. I restauri sull'acropoli di Lindo, in *Memorie dell'Istituto F.E.R.T. II*, Rodi, pp. 11-21.
- Livadiotti, M., La Curia del Foro Vecchio di Leptis Magna: un caso poco noto di anastilosi parziale, in *Selinus 2011, Restauri dell'antico. Ricerche ed esperienze nel Mediterraneo di età greca*, Selinunte 2011, forthcoming.
- Livadiotti, M. and Rocco, G. 1996. (Eds.). *La presenza italiana nel Dodecaneso tra il 1912 e il 1948. La ricerca archeologica, la conservazione, le scelte progettuali*, Catania.



- Mallouchou-Tufano, E. 2003. Il restauro dell'Acropoli, Filetici M.G., Giovanetti F., Mallouchou-Tufano E., Pallottino E. (Eds). I Restauri dell'acropoli di Atene (1975-2003), Quaderni ARCO, Roma, pp. 31,40.
- Mallouchou-Tufano, E. and Alexopoulos, Y. 2003. La documentazione dei lavori di restauro dell'Acropoli e l'uso della tecnologia informatica, Filetici M.G., Giovanetti F., Mallouchou-Tufano E., Pallottino E. (Eds). I Restauri dell'acropoli di Atene (1975-2003), Quaderni ARCO, Roma.
- Mertens, D. 2007. Problemi di restauro (anastilosi?) nell'architettura greca. Tre casi: Paestum, Metaponto, Selinunte, in Progetto archeologico, Progetto architettonico, Università degli Studi di Roma Tre, Facoltà di Architettura, Roma.
- Papachristodoulou, I. 1988. The Anastylis of Ancient Monuments on the Acropolis of Lindos, in Diez S., Papachristodoulou I.(eds) Archaeology in the Dodecanese, Copenhagen.
- Ysma, 2010. M. Ioannidou, E. Petropoulou (Eds). AA.VV. in The Acropolis restoration News, proceedings of a one-day Conference. Modern technologies in the restoration of the Acropolis. Athens.
- Rocco, G. 2002. La figura dell'architetto-archeologo e la formazione universitaria in Italia, in Area 62, pp. 118-123.
- Rocco, G., L'anastilosi dell'antico. Problemi teorici ed esperienze progettuali, in Selinus 2011, Restauri dell'antico. Ricerche ed esperienze nel Mediterraneo di età greca, Selinunte 2011, forthcoming.
- Santoro ,V. 2013. The use of advanced numerical Cad Cam technologies in the integration by stone of a Doric capital, in XXIX Conv. int. Scienza e Beni Culturali Bressanone 2013, pp.607-617.
- Santoro V., La fontana arcaica di Agrigento: primi risultati di un'indagine autoptica delle strutture, in Il restauro dei monumenti antichi. Problemi strutturali: esperienze e prospettive, Atti delle Giornate di Studio, Agrigento, 23-24 novembre 2012, Thiasos, 3, 2014, forthcoming.
- Tocco Sciarelli, G. 2007, Dalle integrazioni lapidee del Bonucci alle impernature metalliche della Fondedile. Gli interventi di restauro dei templi di Paestum tra il 1805 e il 1962, in Atti del Convegno internazionale di Paestum 26-27 giugno 2004, Ravenna, pp. 29-69.
- Vrouva, A., Calculating reinforcement for fragmented architectural members. A three dimensional approach, in Il restauro dei monumenti antichi. Problemi strutturali: esperienze e prospettive, Atti delle Giornate di Studio, Agrigento, 23-24 novembre 2012, Thiasos, 3, 2014, forthcoming.
- Zambas C., 1994. Structural interventions on the Acropolis monuments. Economakis, R. (Ed.). In "Acropolis Restoration", Academy Editions, London, pp. 106-109.

